Finding an ideal level of syncopation to elicit a groove response

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Finding an Ideal Level of Syncopation to Elicit a Groove Response

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1. Objective

- In this study, we used 72 songs from Janata et al.(2012) ranked by listener ratings on their level of perceived groove and measured the amount of syncopation in each song using **Inner Metric Analysis (IMA)** (Volk, 2008).
- Our objective was to use IMA to predict whether a song was high or low groove using a **Binary Classification** task and the listener ratings as a ground truth.

2. Methodology

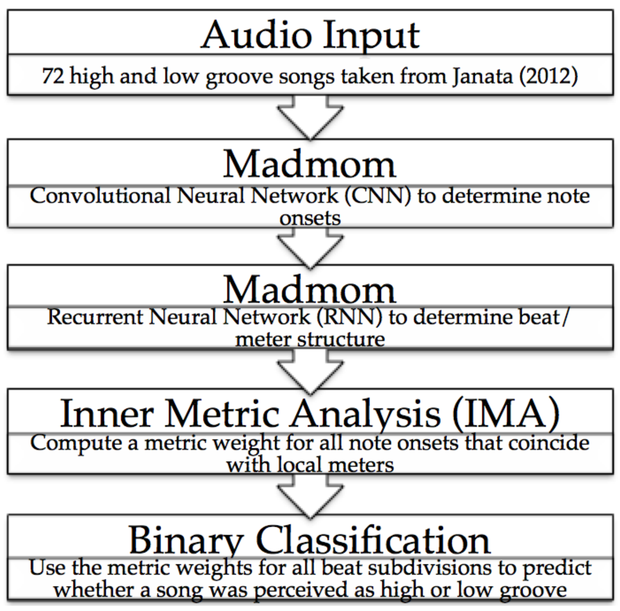

Figure 1: Proposed procedure for modeling the level of syncopation as measured by Inner Metric Analysis (IMA) and the levels of perceived groove.

- We began by using **Madmom** (Böck et. al, 2016) to extract perceptually meaningful metrical structure from the audio of each song.
  - Madmom uses a recurrent neural network (RNN) for detecting downbeats and beats and a convolutional neural network (CNN) to detect onsets through assessing quick changes in spectral content over time.
- Next, we used Inner Metric Analysis to generate a quantifiable metric profile of the onsets return by Madmom.
  - For each song, its metric profile was normalized and the relevant beat subdivisions of all songs were compared.
  - Finally, we used the metric profiles to predict the level of groove (where ratings above 80 were considered high), using a Binary Classification task.

3. Inner Metric Analysis

- Inner Metric Analysis (IMA) provides a hierarchical metric analysis of a song by finding in a list of note onsets all equally-spaced sequences called **local meters** of at least length 3.

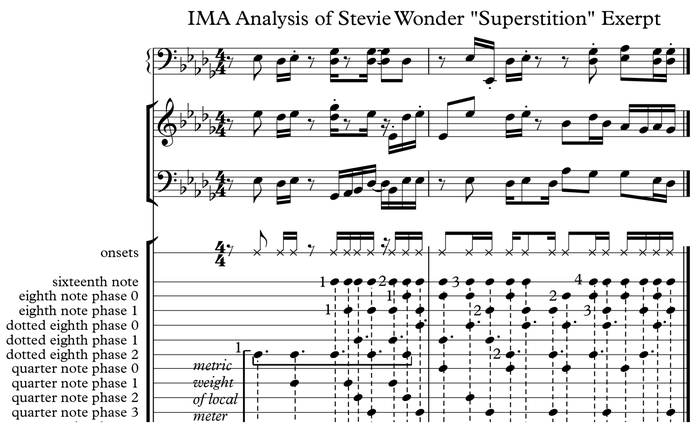

Figure 2: Inner Metric Analysis of an excerpt from Stevie Wonder's "Superstition".

- The **metric weight** of a note onset is found by summing, for all local meters that coincide with this onset, the squared length −1 of each.
  - This quantifies the metrical importance of a song, disregarding the given time signature and bar lines.
- IMA allows us to examine the metrical hierarchies that emerge from the periodicities found in rhythmic patterns, aligning it with **dynamic attending theory** (Large and M. R. Jones, 1999).

4. High vs. Low Groove

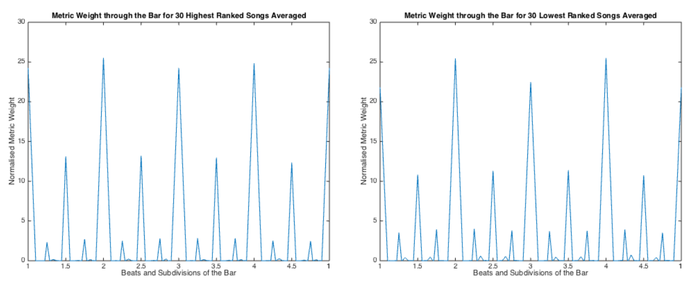

Figure 3: IMA metric weights for each beat subdivision in the top 30 and lower 30 songs rated according to their level of groove (r=.9954).

- Figure 3 might lead us to believe that either
  - The metric structure has little to do with the perceived level of groove; or,
  - Viewing meter as a strict hierarchical structure might erase the unique ways a song elicits groove.

5. Song by Song

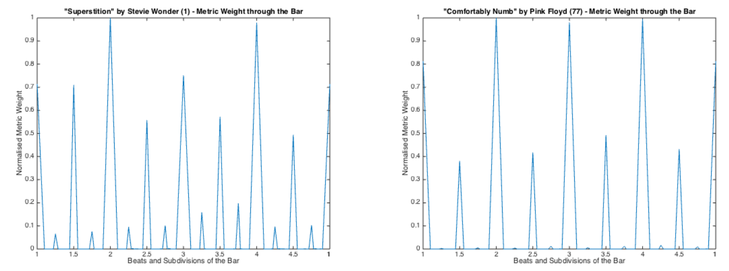

Figure 4: Comparison of metric weights in "Superstition" and "Comfortably Numb" (r=.965).

- On average, high and low groove songs have similar metric coherence according to IMA.
- Low-groove songs generally have higher metrical freedom (both low and high metric coherence).

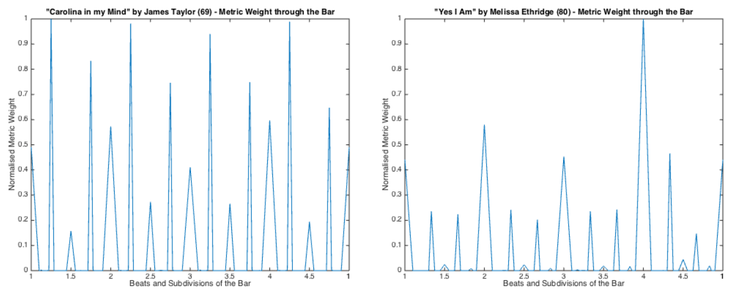

Figure 5: Comparison of metric weights in "Carolina In My Mind" and "Yes I Am" (r=.267).

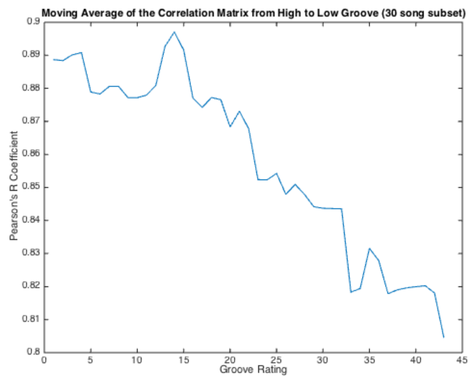

Figure 6: Moving average of correlations across a 30-song subset.

6. Results for Binary Classification Task

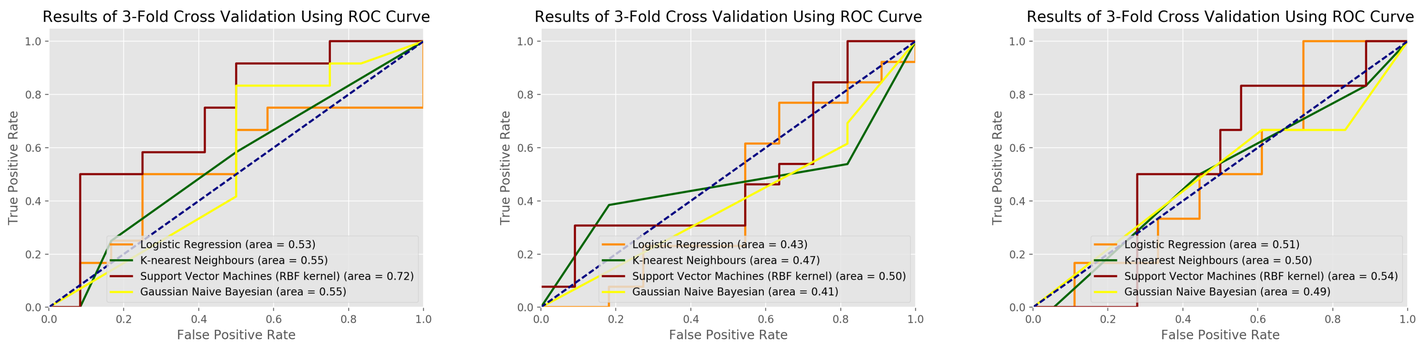

Figure 7: Three folds of cross-validation in using four different models to predict high-groove songs (rating > 80) from the metric weight of beat subdivisions in 72 songs. Preliminary results indicate that the best predictive accuracy (SVM Model: 0.57 +/- 0.02) is not much better than chance, however, univariate feature selection suggests that ['2.667', '1.667', '3.667', '4.333'] are important beat subdivisions.

7. References

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